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ABSTRACT

Many studies using questionnaires and observational methods to collect information on the pointing gesture in infants have recently been performed. However, no study based on long-term observation is presently available that deals with the appearance and development of pointing as an interaction between mothers and their children. Therefore, this longitudinal study was initiated to observe the development of pointing in infants during their first two years. Four Japanese infants (two males and two females) and their mothers were videotaped while playing with certain toys commonly given to Japanese infants. These videotaped sessions took place 15 minutes once a month from the time the infants were 3 to 24 months of age. (In order to provide supplementary data, play interaction between two of the infants and their mothers was also videotaped when the infants were 1 and 2 months old.) Results are reported and discussed in terms of (1) the development, emergence, and function of pointing behavior and (2) behavior related to the emergence of pointing. Specifically examined were the relationship between pointing and emergence of searching behavior with interposed visual representation, eye pointing and the development of infants' capacity to approach interesting objects, and the conditions necessary for the emergence of pointing behavior. Tables and figures summarizing and illustrating the study's results conclude the document. (MP)

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Yoko Y. Wakaba

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DEVELOPMENT OF POINTING IN THE FIRST TWO YEARS

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Studies on language acquirement in infants have focused on verbal behavior. It has recently come to be believed that the development of nonverbal behavior prior to the emergence of verbal behavior plays an important role in the development of verbal communication in infants (Bates et al., 1975; Bruner, 1975, 1977; Bullowa, 1979).

It is believed that pointing, which is a commonly observed nonverbal behavior during infancy, is the first behavior seen as a gesture with reference to things outside the infant (Werner & Kaplan, 1963).

Although infants cannot clearly perceive the outer world during the early stages, they begin to recognize cognitive objects (perceivable object and concept) interposed between themselves and the physical enviroment (Werner & Kaplan, 1963). They come to indicate or communicate cognitive objects by using any possible means of expression. However, these initial processes have not been studied thoroughly as yet.

Pointing is a gestural indication of objects or matters that are recognized by the infants themselves. Meaningful words are a verbal indication of objects or matters that are recognized by the infants.

According to investigators dealing with verbal development, the pointing gesture appears prior to the emergence of meaningful words (Murata, 1968) and the presence of the appearance of the pointing gesture can be used as an indicator to predict the acquirement of speech (Murai, 1976).

We believe that the degree of development of nonverbal behavior used in the interaction between infants and others can provide significant information. We have studied nonverbal behavior in normal infants, with specific focus on the pointing gesture, in order to aid our evaluation of the prognosis of children who have retardation in their language development. Our study, which is based on cross-sectional and longitudinal studies (Wakaba et al.,1979), revealed the following: 1) the pointing gesture does not always occur prior to the emergence

of meaningful words, although it often occurs at that time; 2) individual differences among infants regarding the time of the emergence of the pointing gesture to things that they want (6-11 months after birth) are less than those regarding the time of the emergence of meaningful words (6-15 months after birth); 3) when a mother asks her infant the position of an object, the infant can point to it at age 9 to 16 months. Furthermore, the infant can point at figures in a picture book from age 10 to 16 months; 4) infants can search for a hidden thing using visual representations as cues in an experimental situation before they can spontaneously point to things they want. Another study (Iidaka, Wakaba & Shimada, 1981) revealed that after infants can accurately find the position where a toy is hidden in one of three boxes from ages 6 to 8 months, they begin to point to things that they know to attract their mothers' attention (at age 9 to 12 months).

Many studies on the pointing gesture in infants have recently been performed based on questionnaires and observational methods (Bates et al., 1975, 1979; Ito, 1980; Ishii, 1978; Komatsu, 1978, 1979; Murphy, 1978; Murphy & Messin, 1977; Nakatsuka & Miyake 1979; Ohama et al., 1981; Ohtsuka, 1981; Sato & Nakashima, 1977; Yamada & Nakanishi, 1981; Yamaura, 1971). Videotaping has also been used to observe the situation in detail. However, no study based on long-term observation is presently available that deals with the appearance and development of pointing as an interaction between mothers and their children. Therefore, this longitudinal study was initiated to observe the development of pointing in infants during their first two years.

METHOD

Subjects

Subjects were four Japanese infants (2 males and 2 females) and their mothers who fulfilled the following criteria:

1) The infants were born at full term, and no abnormal findings were observed at birth by their obstetricians.

2) A pediatric neurologist determined that the infants had grown favorably since birth.

3) The infants were their parents' first child, and were cared for by their mothers.

4) The parents were physically and mentally healthy and had graduated from a school above high school.

5) The condition of their home was economically and psychologically stable.

Procedures

Certain toys were placed in a small room for this study. Situations where the infants and their mothers were playing were recorded by videotape for 15 minutes once a month from 3 to 24 months following their birth. The mothers were instructed to play with their infants as they did at home.

The following toys were given to each infant at ages 3 to 11 months: a teething ring, a small and large rattle (a sound is produced when it is waved), a vinyl duck (a sound is produced when it is pushed), a self-righting toy (a sound is produced when it is rolled), a vinyl hammer (a sound is produced when it hits something), a stuffed doll for girls, a stuffed bear, and two telephones. These toys are commonly given to infants in the ordinary Japanese home. In addition to these toys, except for the teething ring and the small and large rattle, the following toys were given to each infant at ages 12 to 24 months: a boy's doll, a girl's doll, a vinyl animal, four picture books, a car, two mini-cars, two mini-buses, blocks, a wooden wagon for blocks, and a ball. These toys are also commonly given to infants in the ordinary Japanese home.

The videotape was transferred to another tape with digital indications and repeatedly observed. Pointing behavior and related behaviors were observed in both mothers and their infants. A situation where 2 of the infants (A and B) were playing with their mothers when they were 1 and 2 months old was also recorded by videotape for use as supplementary data.

Supplementary data

A questionnaire on which each mother recorded the general development of her child every month and experimental data on visual representations in each infant (Shimada, 1979) are used.

RESULTS AND DISCUSSION

1. Development of pointing behavior

a) The emergence of pointing behavior

There are two ways of pointing, i.e., contact pointing (infants point at an object by directly touching it with their finger) and separate pointing (the finger does not touch the object to which the infant points). In contact pointing, the point where the finger touches an object indicates the object; in separate pointing, the direction in which the finger points indicates the object. In order to examine the occurrence of both contact and separate types of pointing, the following situations were observed: 1) 5 seconds before either mother or infant pointed at or to an object, the behavior of the other person; 2) the behavior of both mother and infant when either mother or infant pointed at or to an object; 3) 5 seconds after either mother or infant pointed at or to an object, the behavior of the other person. Simultaneously, gaze, the object pointed at, vocalization or speech, and physical movements were recorded.

The first contact pointing in all subjects occurred at age 8 to 11 months with an average of 9.3 months. On the other hand, the first separate pointing occurred at age 10 to 17 months with an average of 12.7 months. As for the mothers, contact pointing occurred when infants were 7 to 17 months of age (an average, 10.7 months) and separate pointing occurred when infants were 7 to 22 months (an average, 12.7 months). The frequency of pointing behavior in both mothers and their children is shown in Figs. 1-4. Separate pointing was less frequent in both mothers and infants because the situation in the experimental room was not prepared in a way which facilitated separate pointing. Contact pointing in both mothers and infants was most often seen in pointing at a picture book. This was frequently seen 12 months after birth or subsequently (when infants began to be interested in picture books).

Escalona (1973) reported that adults began to point at objects to attract infants' attention when the infants were 7 or 8 months old. This is earlier than when the infants begin to point at objects, i.e., 9-12 months (by Sato, 1977, who reported that 99.2% of the infants they studied begin to pointing at an object prior to 12 months of age). That is, it seems that pointing behavior

in mothers begins earlier than in their infants. Many investigators have observed that pointing behavior in mothers occurs prior to their infants'.

In subjects A (female) and B (male), the emergence of pointing in mothers preceded their infants. However, this was not observed in subjects C (female) and D (male). The mothers' behavior towards their children differed in subjects A and B and subjects C and D. Nonverbal behavior was diversified in subjects A and B, and not in subjects C and D. As for verbal behavior, mothers of subjects A and B significantly diversified their speech so that their infants might be able to learn various features of the object they spoke about. On the other hand, mothers of subjects C and D spoke simply and they often made disagreeable responses to approaches from their infants (Iitaka, 1979). Therefore, it can be said that when the mother's behavior is diversified, objects are frequently pointed at to attract the attention of their infants.

b) The function of pointing

Table 1 shows the first instance of pointing in mothers and their infants. Bates et al. (1975) classified pointing into noncommunicative pointing and communicative pointing. The first instance of pointing in all subjects was observed in a communicative situation.

In regard to subsequent pointing, contact pointing was used in most cases when both mothers and their infants pointed at a certain part of the object around the infants. Of course separate pointing was used when both mothers and their infants pointed to objects at a distance from their index fingers. Furthermore, when situations where contact and separate types of pointing occurred were examined in detail, both mothers and their infants pointed at or to objects present in the visual field of the other person during the early stages and their pointing behavior was accompanied by sounds or language when the objects were not present in the other person's visual field. That is, infants point at or to objects present in the visual field shared by both themselves and their mothers. This also can be said to be the case in mothers. However, mothers in whom the emergence of pointing behavior was later than that of their infants did not point at or to objects at a time when the infants were gazing at the object. That is, when these mothers pointed at or to an object, they did not pay attention to whether or not the visual field was shared by both themselves and their infants.

Subsequently, both mothers and their infants began to point at or to objects that were in different visual fields as the infants began to positively respond to the outer world and as they began to gaze at various objects around them. Consequently, their mothers did not always follow the objects at which their infants were gazing.

Infants voluntarily pointed at or to objects to attract their mother's attention in some cases and to respond to their mothers' actions in the other cases. Voluntary pointing behavior of infants towards their mothers attracts their attention. Therefore, pointing plays a role in demonstrating the objects which both the mother and infant are concerned with in the interaction between mother and the infant. This has the same effect as the following in the behavioral context: 1) Infants point at or to an object they want. (I want "this"); 2) They point at or to an object to ask ("what's "this"); 3) They point at or to an object they gaze at (I'm looking at "this"). "This" in these situations corresponds to pointing.

When infants respond to their mothers' actions, they respond verbally if they can; however, because they are not able to speak during their early stages, they point at or to the objects their mothers speak about. This responding behavior suggests that the infants understand the necessity of responding to their mothers' actions by some means and they also understand the property of language in their responding to their mothers' actions. The author therefore considers that such pointing behavior in infants functions as language.

The next step in the pointing behavior of infants is when they point to the position and direction of objects when their mothers ask. This becomes possible when infants can understand what their mothers are saying. Pointing is accompanied by communicative vocalization during the early stage. As vocabulary increases, pointing is accompanied by words. After sentence structure is mastered, pointing begins to be accompanied by sentences.

These processes suggest that pointing in infants has the function of selecting an object from their environment and expressing it and that pointing comes to be accompanied by speech which has the function of more definitely indicating the content to be expressed.

Pointing is not initiated before infants wish to express something to their mothers. A means of expression, i.e., the capacity to make clearly a recogniz-

able shape with the fingers, must be available for the infants in order to express what they mean. However, if infants can product link of sounds as socially accepted and they cannot make point with their fingers, the emergence of meaningful words seems to precede pointing.

From this, we believe that the use of pointing closely correlates with the development of the capacity for verbal communication. This aspect of correlation should be studied further.

2. Behavior related to the emergence of pointing

a) The correlation between pointing and the emergence of searching behavior with interposed visual representations, and of showing and giving

Bates et al. (1975) reported that showing, giving, and pointing occur at the same time.

There is a correlation between pointing and the certain object being pointed at; i.e., pointing (significant) means a certain object (signifié). The differentiation between significant and signifié must be observed. Therefore, the behavior of infants in the experimental situations was observed to exemplify the differentiation between significant and signifié. It was found that when a toy which an infant had gazed at and handled was hidden in one of 3 boxes in front of the infant, he (she) was able to gaze at and handle the box. Morehead & Morehead (1974) interpreted the behavior of infants who are able to search for a hidden object properly as the denoting of the differentiation between the object that means (the position of a hidden object) and the object that is meant (a hidden object). It is therefore considered that the behavior of infants who gaze at and handle a box in which a toy is hidden exemplifies the differentiation between significant and signifié. The age of infants who can gaze at and handle the box in which a toy was hidden is regarded as the age of "the first appearance of goal-orienting behavior", and the age of infants who gaze at and handle only the box in which a toy is hidden was regarded as the age of "establishment of goal-orienting behavior" (Shimada, 1979). Figure 5 shows the order of the emergence of four kinds of behavior in infants, of the emergence of three kinds of behavior in mothers, and of the emergence of shared activity, in which the visual world shared by both infants and their mothers.

When infants were 3 months old, both infants and their mothers had already experienced gazing at the same toy (sharing the same visual world) and handling

it together. "Showing" is the behavior in which a man is showing an object in his hands to another person. The man showing an object shares the visual world with the other person. "Pointing" is considered to be the more progressive behavior of "showing".

When the infants were 3 months old, "showing" and "giving" were seen in mothers, followed by contact and separate pointing. That is, "showing" was followed by "pointing".

In the case of infants, contact pointing followed "showing" (A, B, C) or both behaviors occurred at the same time (D), followed by separate pointing. However, there was no correlation between giving and contact and separate pointing with regard to the order of their emergence. This suggests that contact pointing occurs earlier than separate pointing because the latter type of pointing is more symbolic. However, data obtained from the present study could not clarify the order of the emergence of both types of pointing.

With regard to a correlation between goal-orienting behavior for a hidden toy and pointing, goal-orienting behavior always preceded separate pointing, suggesting that the infants could recognize that the position of a hidden toy (significant) means the hidden toy (signifié) earlier than that the direction of pointing (significant) means the object of pointing (signifié). The differentiation between significant and signifié in relation to the emergence of pointing should be studied further. It is also necessary to clarify what produces the differentiation between significant and signifié and how the degree of the differentiation between them progresses in the emergence of pointing.

b) Eye pointing and the development of infants' capacity to approach interesting objects

In a real situation where infants and their mothers were playing, when infants were gazing at a toy, their mothers picked it up and brought it close to the infants. Such gazing behavior has the same effect as pointing behavior for demand, and Grey (1978) called it "eye pointing". When eye pointing is seen, mothers begin to interpret the gaze of their infants as significant behavior. It is important to clarify how mothers and their infants came to bind by exchanging such a visual gaze.

From the fact that infants extend their pointed finger to an object in pointing behavior, the infants' motor capacity to approach an object must be

developed. When the infants are able to reach an object readily, the degree of the necessity to communicate with their mothers to ask their help by means of pointing decreases. The process of development of pointing in subjects A and B was examined from 1 month after birth to the emergence of contact pointing. The results are shown in Tables 2 and 3.

As was already been mentioned, mutual interaction between mothers and their infants was diversified and active. Furthermore, pointing was used frequently in both mothers and their infants in their mutual interaction from the earliest stages.

Mutual gazing between infants and their mothers was observed when infants were 1 month old. Simultaneously, visual-visual communication between mothers and their infants was established. When infants gazed at a toy, a co-oriented gaze was noted in their mothers. Furthermore, when infants did not gaze at the object their mothers showed them, their mothers stopped showing it. When the infants were 1 month old, infants and their mothers already shared the same concerns. This was established because the mothers followed their infants' gaze. This has also been reported by Collis (1977). At 3 months of age, infants began to gaze at objects around them more frequently. Visual communication between infants and their mothers was seen when both of them shared the same visual world by gazing at the same object. This is the basis that initiates pointing.

The early stage of gazing in infants has the function of attracting their mothers' attention and changing their mothers' behavior. At 4 months of age, infants' mothers picked up an object their infants gazed at and drew it close them. This occurred because the mothers recognized that the infants' capacity to approach the object with their hands and the infants' capacity to handle and hold it had already developed. The phenomenon seen at this stage is so-called "eye pointing". Because the mothers reaction to their infants' gaze was observed - i.e., mothers moved objects to adapt to their infants' demand represented by the infants' gazing -, an eye pointing loop was established.

At 5 or 6 months of age, eye pointing was sometimes accompanied by reaching. Mothers responded more receptively to eye pointing accompanied by reaching than to eye pointing alone because adults have more experience with behavior in which an adult gazes at an object, stops other movements, and then extends his

hands towards the object with the purpose of touching or holding it. That is, adults understand that reaching is not merely an action but also a gesture that means a desire to approach the object at which one gazes.

In the next step, as the infants' capacity to approach an object, accompanied by movements of the upper body, increases, the mothers did not respond as receptively to the eye pointing of their infants or to eye pointing accompanied by reaching (sometimes accompanied by movements of the upper body to approach the object).

Finally when infants could walk holding onto somethings or could walk by themselves and could approach an object more readily than before, they stopped eye pointing or eye pointing accompanied by reaching.

Mothers respond receptively to the behavior of infants who are gazing at various objects during the early stages. However, as it becomes possible for infants to approach, select, and handle interesting objects by themselves (at the age of 6 or 7 months), the degree of their mothers' receptive responses decreases. From that time, eye pointing begins to be accompanied by reaching in order to give more significant information to the mothers who do not respond to the infants' eye pointing as receptively as before.

Contact pointing did not occur until eye pointing and eye pointing accompanied by reaching became inactive. It seems that the following conditions are established prior to the emergence of contact pointing after infants have frequently experienced that their reaching is interpreted as significant behavior and is responded to: 1) Infants recognize that certain behavior is interpreted as a gesture; 2) They can point with their fingers; 3) They can recognize a certain part of objects around them by visual representations.

Separate pointing, which occurred 1 to 3 months later than contact pointing, was used to communicate to their mothers the object the infants perceive or know. A developmental study of comprehension for pointing (Ito, 1980), which was based on an experiment, quoted that infants could comprehend pointing at objects near to them earlier than the pointing to objects distance from them. This suggests that contact pointing emerge earlier than separate pointing. According to previous studies (Yamaura, 1971; Sato et al., 1977; Komatsu, 1979), it seems that separate pointing was seen when infants point to food they want or to objects that they want to touch separate from them frequently occurs earlier

in daily life than the aforementioned separate pointing. However, the present data could not clarify the definite time of the first appearnace of separate pointing.

c) Conditions for the emergence of pointing behavior

In addition to the previously mentioned conditions before emergence of pointing behavior which seem attributable to the infants' experience and capacity precedent to the pointing behavior, it also seems necessary for infants to be exposed to their mothers' pointing behavior. This may be because mothers point at or to an object present in the visual field of their infants and because they confirm whether or not the infants gaze at the objects. If the infants do not gaze at an object, the mothers attempt to attract their infants' attention by using verbal behavior. Murphy et al. (1977) also found that when mothers used separate pointing with their infants, they simultaneously looked at the object being pointed to and looked at their infants. That is, mothers usually confirm whether or not their infants gaze at the object at or to which they point. Such an experience makes the infants expect the same behavior in their mothers when they point at or to an object. Although the present study could not conclude who used either contact or separate pointing earlier, mothers or their infants, the manner of the infants' behavior suggested that the emergence of pointing behavior in mothers preceded that of their infants.

When infants point at or to an object they gaze at, the integration of vision and the movement of fingers, and the infants' capacity for poking are necessary. During the early stages of integration of vision and physical movement, the infants attempt to touch an object they are gazing at. This behavior progresses with age - the infants become able to move their body close to the object at which they gaze. Yamaura (1971) reported that poking has already been established in infants who can point to objects. This also seen in these subjects.

Figures 6 and 7 summarize the infants' experience and capacity prior to pointing. That is, the following conditions must precede the pointing behavior of infants: 1) Symbolic function must be developed; 2) Visual-visual communication between mothers and their infants must be established; 3) The meaning of the infants' gazing behavior must be acquired; 4) An eye pointing loop must be established; 5) The capacity for movement of the fingers and the whole body

must be developed (the development of the capacity for movement integrated in gazing behavior and the development of poking are included); 6) The infants' behavior must be interpreted as significant and have meaning for their mothers; and 7) The infants must understand the meaning of their mothers' pointing. Furthermore, it seems that the infant's capacity to selectively perceive an object around him must be developed. However, this aspect was not dealt with in the present study.

The present study dealt with the process of the development of pointing behavior in detail in several subjects. Further study with many subjects may determine whether or not the present phenomena are universal.

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Table 1 Objects pointed at in the first pointing of mothers and infants

Subject	Contact pointing		Separate pointing	
	Mother	Infant	Mother	Infant
A	Pendant hanging from her neck (7M)	Eye of the teddy bear on her lap (11M)	Doll which is at a distance of 1 meter from the infant (10M)	Picture of an elephant in a book near her standing foot (13M)
B	Eye of the teddy bear whose nose the infant is already touching (9M)	Nose of the teddy bear which he brought (9M)	Small rattle which is in the infants hand (9M)	The ceiling of the room (10M)
C	Ornament on the foot of the doll which the infant is manipulating (10M)	Teething ring which is in the mothers hand (8M)	Small rattle near the infant (7M)	The video camera in the room (11M)
D	Wooden wagon which is at a distance of 50cm from the infant (17M)	Big rattle which is being held by both the mother and him (9M)	Mini-bus which is at a distance of 40cm from the infant (22M)	Wooden wagon which is also pointed at by the mother at a distance of 50cm from him (17M)

Note: M refers to the infant's age in month

Table 2. The Process of the Emergence of Eye Pointing and Development of the Infant's Capacity to Approach an Interesting Object (Subject A)

Age	The infant's behavior towards things of interest and her mother's response to it	The infant's capacity to approach an interesting toy	Eye pointing
1 mo.	The infant is held in her mother's arms in a face to face position The infant continues to gaze at her mother's face. ⟶ The mother continues to gaze at the infant. The infant is held sideways in her mother's arms When the mother waves a small rattle, the infant does not look at it, but only gazes at the mother's face. ⟶ The mother stops showing it.	The infant has no capacity to approach an interesting toy.	Visual-visual communication between mother and her infant is established. The mother recognizes an object at which the infant gazes as an interesting one and responds receptively to the infant's gazing.
2 mos.	The infant is held in her mother's arms in a face to face position The infant continues to gaze at the mother's face ⟶ The mother continues to gaze at the infant. Same posture While the infant is looking at the mother's arm, she is touching it. ⟶ The mother looks at the infant touching the mother's arm. The infant is held sideways in her mother's arms The infant continues to gaze at her mother's face, even though the mother waves a small rattle (sound is produced). ⟶ The mother stops showing it.	The infant can touch an interesting toy, if the toy is placed near the tips of her fingers.	Even if the mother shows a toy, her infant does not look at it and continues to gaze at the mother's face.
3 mos.	The infant is lying on her face When the mother waves a large rattle in front of her infant's face, the infant continues to gaze at it, and then, touches it. ⟶ The mother gazes at her infant gazing at the large rattle and when the infant looks away, the mother stops showing it.	If an interesting toy is placed near the infant's hands, the infant can extend her hands towards the toy to touch it.	The infant gazes at and touches the toy the mother shows.

4 mos.	The infant is lying on her face The infant gazes at* a self-righting toy next to her head, begins to whine, and looks away from the toy. ⟶ The mother places the self-righting toy in the place where the infant can touch it.	The infant can touch an interesting toy, if the toy is placed in the range where the infant can touch it.	When the infant continues to gaze at an object placed where the infant cannot touch it, the mother may bring it close to the infant (* establishment of eye pointing). Eye pointing is sometimes accompanied by signal vocalization.
5 mos.	The infant is lying on her face When the mother takes a doll away from her lap, her infant follows* the doll. ⟶ The mother shows the doll with her hands in front of the infant's face. Same posture After the infant continues to gaze at a self-righting toy the mother rolls (sound is produced), the infant looks away from it. ⟶ The mother picks up the doll and gives it to her. The infant is sitting Even though the mother produces a sound with a vinyl duck near the infant, the infant does not look at it. ⟶ The mother stops showing it.	The infant can, although unsteadily, sit by herself. The infant can extend her hands and hold a toy steadily, if the toy is placed in the range where the infant can touch it.	* Eye pointing is seen.
6 mos.	The infant is standing, being held upright in her mother's hands The infant gazes at* the duck on the floor (but cannot touch it). ⟶ The mother picks it up and gives it to the infant. The infant is sitting The infant picks up the duck near to him and handles the duck. When the duck rolls to an area where the infant cannot reach with her hands, the infant extends her hands towards it continuing to gaze at** it. ⟶ Immediately, the mother picks it up and gives it to the infant. The infant is lying down The infant gazes at** a duck on left side and extends her hands towards the duck (the infant cannot touch it) ⟶ The mother picks it up and lets the infant hold it in her hands.	The infant can sit without help. Even if an interesting toy is placed in the place where the infant cannot touch it, the infant can lean forward and reach with her hands to hold it (The range where the infant can reach with her hands becomes larger).	* Eye pointing is seen. ** Eye pointing accompanied by reaching is seen. The mother interprets the reaching of the infant as significant behavior and responds receptively to it (she gives an object to her infant).

* eye pointing

** eye pointing accompanied by reaching

	The infant is standing, being held upright in her mother's hands The infant gazes at* a self-righting toy on the floor.⟶ The mother rolls it and produces a sound. Same posture The infant continues to gaze at* a self-righting toy on the floor.⟶ The mother moves the infant to a position where the infant can touch the toy and has the infant sit. The infant is sitting on her mother's lap The infant is continues to gaze at* a doll on the floor (she cannot touch it). ⟶ The mother picks it up and lets the infant hold it in her hands. The infant is lying down The infant continues to gaze at** a self-righting toy on her left side and reaches with her left hand (but cannot touch it).⟶ The mother places the toy near the infant. The infant is sitting The infant continues to gaze at** a self-righting toy and reaches with her hands (but cannot touch it).⟶ The mother moves the infant to a position where she can touch the toy. The infant is sitting on her mother's lap The infant continues to gaze at** a self-righting toy and extends her left hand towards it (she can touch it if she stretch the hands).⟶ The mother helps the infant lean forward to pick up the toy by herself by supporting the infant with her hands. The infant is creeping The infant continues to gaze at** a telephone and extends her hands towards the telephone. But, because the infant cannot touch it, she begins to whine. ⟶ The mother brings the telephone near her infant. The infant is sitting The infant continues to gaze at* a doll (but cannot touch it). After she continues to gaze at** the telephone, the mother brings it near her.	The infant can sit steadily by herself. The infant can reach with her hands: If the infant is held in her mother's hands, the infant can lean forward and extend her hands towards the toy placed at a further distance from the infant.	* Eye pointing is seen. The mother does not respond as receptively to eye pointing as before. ** Eye pointing accompanied by reaching are seen, sometimes accompanied by signal vocalization. ↓ The mother responds receptively to her infant's behavior (she brings an object, which is a distance where the infant cannot reach, to a place where the infant can touch it, makes her infant hold it in her hands, or moves her infant close to an object).

8 mos.	The infant is lying down While the infant is playing with a small rattle, the mother waves a teething ring (produces a sound) in front of her infant's face, but her infant only glances at it and looks away.⟶ The mother stops showing the teething ring. The infant is sitting The infant continues to gaze at* the doll and the teething ring (but cannot touch them).⟶ The mother picks up the doll and puts it close to the infant. However, when the mother noticed that her infant continues to gaze at* the teething ring, she picks it up and brings it closer, to a position where the infant can touch it. The infant is sitting on her mother's lap The infant continues to gaze at* a small rattle on the floor (but cannot touch it).⟶ The mother picks it up and gives it to her infant. The infant is sitting While the infant is gazing at** a doll, she opens her left hand and extends it towards the doll (but cannot touch it).⟶ The mother brings the doll closer, to a position where the infant can touch it. The infant is lying down The infant faces towards the left side, continues to gaze at** a self-righting toy on the left side, and extends her right hand towards the toy (but cannot touch it).⟶ The mother draws the self-righting toy closer, to a position where the infant can touch it. The infant is standing, being held upright in her mother's hands While the infant continues to gaze at** a self-righting toy on the floor, she extends both hands and leans forward towards the toy (but cannot touch it).⟶ The mother holds the upper part of the infant in her hands and moves the infant close to the toy.	The infant can sit steadily by herself. The infant can lean forward and reach with her hands to touch the toy and surrounding objects at sitting posture.	The mother interprets the object that the infant gazes at as an interesting one. * Eye pointing is seen. ** Eye pointing accompanied by reaching (sometimes accompanied by movements of the entire body) are seen.

9 mos.	The infant is sitting A small rattle rolls from the infant's hand to the floor, and the infant gazes at* the rattle.⟶ The mother immediately picks it up and gives it to the infant. Same posture While the infant is looking at** a telephone, placed where she can touch it, she extends her hands.⟶ The mother watches the infant's behavior.	The infant can approach an interesting toy by creeping. The infant can sit steadily by herself. The infant can lean forward and can change her body's direction, thereby enabling the infant to touch an object placed at a greater distance from the infant at sitting posture.	* Eye pointing is seen. ** Eye pointing and reaching are seen. ↓ If the infant can approach an interesting object by herself, the mother does not help.
10 mos.	While the infant is continuing to gaze at an interesting toy, she creeps to approach the toy.⟶ The mother watches her infant's behavior without helping. The infant does not extend her hands towards a toy continuing to gaze at it.	The infant can approach an interesting toy by creeping or walking to hold onto something.	Neither eye pointing nor eye pointing accompanied by reaching is seen. ↓ The infant can reach interesting objects by herself. The mother watches the infant's behavior without help.
11 mos.	The infant neither gazes at toys not extends her hands towards them continuing to gaze them.	The infant can stand up by herself and can walk, sometimes holding something, to approach an interesting toy.	Neither eye pointing nor eye pointing accompanied by reaching seen.

Table 3. The Process of the Emergence of Eye Pointing and Development of the Infant's Capacity to Approach an Interesting Object (Subject B)

Age	The infant's behavior towards things of interest and her mother's response to it	The infant's capacity to approach an interesting toy	Eye pointing
1 mo.	The infant is lying on his face The infant continues to gaze at his mother's face in spite of his mother's showing and shaking a small rattle.⟶ The mother continues to gaze at the infant and stops to shake. Same posture When the mother waves a small rattle, the infant does not look at it, but continues to gaze at the mother's face, then he looks at the small rattle.⟶ The mother continues to gaze at the infant. Same posture The infant gazes at the teething ring when mother shakes it near his face.⟶ The mother continues to look at the infant's face.	The infant has no capacity to approach an interesting toy.	Visual-visual communication between mother and her infant is established. The mother recognizes an object at which the infant gazes as an interesting one and responds receptively to the infant's gazing.
2 mos.	The infant is held in his mother's arms in a face to face position on mother's lap The infant gazes at the mother while he is sucking.⟶ The mother continues to look at the infant's face. The infant is lying on his face The infant gazes at the mothers face with vocalization when the mother shakes the infant's hand with her hand.⟶ The mother continues to look at the infant's face. The infant is held in his mother's arms in a face to face position on mother's lap When mother shows and shakes the small rattle in his visual field, the infant does not look at it, but continues to gaze at the mother ⟶ The mother stops shaking it.	The infant cannot touch an interesting toy, even if the toy is placed near the tips of his fingers.	Even if the mother shows a toy, her infant does not look at it and continues to gaze at the mother's face.

2 mos.	The infant is lying on his face When the mother shows and shakes a small rattle and shows a vinyl duck which produces sound near his face, the infant does not look at them, but continues to gaze at the mother's face.		
3 mos.	The infant is lying on his face The infant looks the teething ring and vocalizes when the mother shakes it near his face. The mother has the infant hold it in his hand, after gazing at the infant's face.	The infant can hold a toy and shake his hand with the toy if the mother lets the infant hold it in his hand.	The infant gazes at objects which mother shows.
4 mos.	The infant is held in his mother's arms in a face to face position on her lap When the mother draws a self-righting toy close to the infant, the infant gazes at it. ⟶ The mother looks at the infant gazing. The infant is sitting on its mother's lap The infant *gazes at the vinyl duck on the floor (he cannot reach it). ⟶ The mother lets the infant hold it in his hand.	If an interesting toy is placed near the infant's hands, the infant can extend his hands towards the toy to hold it.	When the infant continues to gaze at an object placed where the infant cannot touch it, the mother brings it closer to the infant (* establishment of eye pointing).
5 mos.	The infant is lying on his face The infant gazes at the vinyl duck, holding it in his hand by himself. Then he stops to gaze. ⟶ The mother takes away it immediately and has the infant hold the big rattle in his hand. The infant is sitting on his mother's lap When mother puts the bear in front of the infant's face, the infant looks at it but soon stops. ⟶ The mother puts it on the floor, takes the small rattle and has the infant hold it in his hand. Same posture The infant touches the self-righting toy while looking at it, then takes his eyes off it and looks right and left. ⟶ The mother takes off it immediately. The infant is lying on his face The infant drops the vinyl duck which was held by him with his hand, and gazes* at the bear which is held by the mother. ⟶ The mother brings it closer to him.	Even if the infant cannot reach an interesting toy by himself, he can reach it by stretching his upper body and hands when held in mother's hands in a sitting posture (the range he can reach has expanded).	If the infant turns his gaze away from an object, the mother takes off it (the mother interprets the gaze of her infant as a representation of interest and responds receptively). * Eye pointing is seen. ** Eye pointing accompanied by reaching is seen (sometimes accompanied by stretching of the upper body). ↓ The mother interprets the reaching of the infant as significant behavior and responds receptively to it (she gives an object to her infant, or placed it in the range where the infant can touch it).

* eye pointing
** eye pointing accompanied by reaching
*** eye pointing accompanied by reaching and vocalization

5 mos.	The infant is sitting, being held in his mother's hands The infant reaches for the self-righting toy continuing to gaze at** it in front of him (he cannot reach it).⟶ The mother brings it closer to his hand. The infant is sitting on his mother's lap The infant reaches out with his hands and body to the self-righting toy continuing to gaze at** it (he cannot reach it).⟶ The mother lowers the infant to allow his hand to reach it. Same posture The infant lowers his upper body stretching his arm to the vinyl duck while gazing at** it (he cannot reach it).⟶ The mother takes the duck and lets the infant hold it in his hand.		
6 mos.	The infant is sitting, being held in mother's hands After the infant gazes at the self-righting toy, he soon turns his gaze* to the bear to the right of it.⟶ The mother co-orients with the infants gaze and looks at the same object the infant does. The infant is sitting, being held in his mother's hands on his mother's lap When the mother brings the bear close to the infant, the infant gazes at it. The infant is sitting, being held in his mother's hands When mother shows and shakes the big rattle, the infant gazes at and holds it. Same posture After the infant gazes at and touches the self-righting toy, suddenly he gazes at** and touches the bear beside it (he cannot draw it up to himself because the bear is too big).⟶ The mother puts the bear in front of him. Same posture The infant gazes at** the big rattle to the left of him continuing to stretch his left hand and upper body to it (he cannot reach it).⟶ The mother brings the infant's body closer to it while holding him in her hands.	The infant can sit with the mother's help. If an interesting toy is placed where the infant cannot touch it, he cannot extend his hand or stretch his body without help. If the toy is in touching range, he can touch and hold it.	* Eye pointing is seen. ** Eye pointing accompanied by reaching (or by touching) is seen, sometimes accompanied by stretching of the body too. ↓ The mother responds to eye pointing accompanied by reaching receptively and moves the infant's body closer to the object or moves the object closer to the infant's if the object is out of the infant's reach.

7 mos.	The infant is sitting. The infant turns his gaze from the small rattle and looks to the right.⟶ Immediately the mother shakes her hand in the visual field of the infant. The infant is sitting, being held in mother's hands in a face to face position on his mother's lap The infant moves head to right and looks ahead, then moves head to left and looks ahead.⟶ Mother co-orients* with the infant's line of vision and moves her eyes in the same direction. The infant is sitting The infant turns his gaze from the toy and looks at** the mother's lap, then he touches it.⟶ Immediately the mother holds him in her arms. Same posture The infant reaches with his right hand to the small rattle continuing to gaze at** it.⟶ The mother takes it and lets the infant hold it. The infant is sitting, being held in the mother's arms in the back to face position on mother's lap The infant stretches his upper body over the floor continuing to gaze at** the small rattle on the floor.⟶ The mother takes it and lets him hold it.	The infant can continue to sit by himself, although unsteadily. The infant can extend his hands and hold a toy steadily when he is in sitting posture, if the toy is placed in the range where the infant can touch it. If he is in another posture, he can extend his hands and hold it stretching his body with help.	* Eye pointing is seen. ** Eye pointing accompanied by reaching is seen (touching is also seen. Sometimes accompanied by stretching of the body). The mother moves the infant's body closer to the object or moves the object closer to the infant when the object is out of the infant's reach.
8 mos.	The infant is sitting in a face to face position When mother shakes the teething ring in the infant's visual field, the infant reaches his right hand toward it continuing to gaze at** it (he cannot reach it).⟶ The mother lets the infant hold it. Same posture The infant reaches with his right hand to the bear which mother holds in her hands continuing to gaze at** it (he cannot reach it).⟶ The mother puts it in a location where the infant can reach. The infant is sitting The infant reaches with hand on the telephone continuing to gaze at** it (He cannot touch it but he can reach it if he stretches his upper body).⟶ The mother sees that and does not help the infant.⟶ The infant stretches his upper body and holds it by himself. The infant is sitting in a face to face position After the infant vocalizes continuing to gaze at*** the mother's face, the infant touches the mother's lap with his right hand and starts to climb into her lap.⟶ The mother holds him in her hands.	The infant can sit steadily by himself. Even if an interesting toy is placed where the infant cannot touch it, the infant can lean forward and reach with his hands to hold it in sitting posture.	** Eye pointing accompanied by reaching is seen, sometimes accompanied by vocalization for demand (***). ↓ If the infant can approach an interesting object by stretching his body by himself, the mother does not help. If accompanied by vocalization for demand, the mother helps actively.

8 mos.	Same posture When mother shows the bear which she holds in her hands, the infant vocalizes and stretches his right hand to it continuing to gaze at*** it.⟶ The mother brings it to where the infant can reach it.		
9 mos.	The infant is sitting The infant continues to gaze at* the bear (he can reach it if he stretches his arm).⟶ The mother does not bring it closer. Same posture When the mother hits a vinyl hammer producing a sound, the infant stretches his right hand to it continuing to gaze at** it.⟶ The mother moves it to where the infant can reach it. Same posture The infant stretches his hands to the self-righting toy continuing to gaze at** it (he cannot touch it, but he can if he turns his body).⟶ The mother does not move it closer to him.	The infant can approach an interesting toy by creeping. The infant can sit steadily by himself. The infant can lean forward and change his body's direction, thereby enabling the infant to touch an object placed at a greater distance from the infant.	* Eye pointing is seen. ↓ If the infant can approach an interesting object by himself, the mother does not help. ** Eye pointing accompanied by reaching (or by touching) is seen. ↓ The mother does not help except when the mother hopes the infant will manipulate the object.

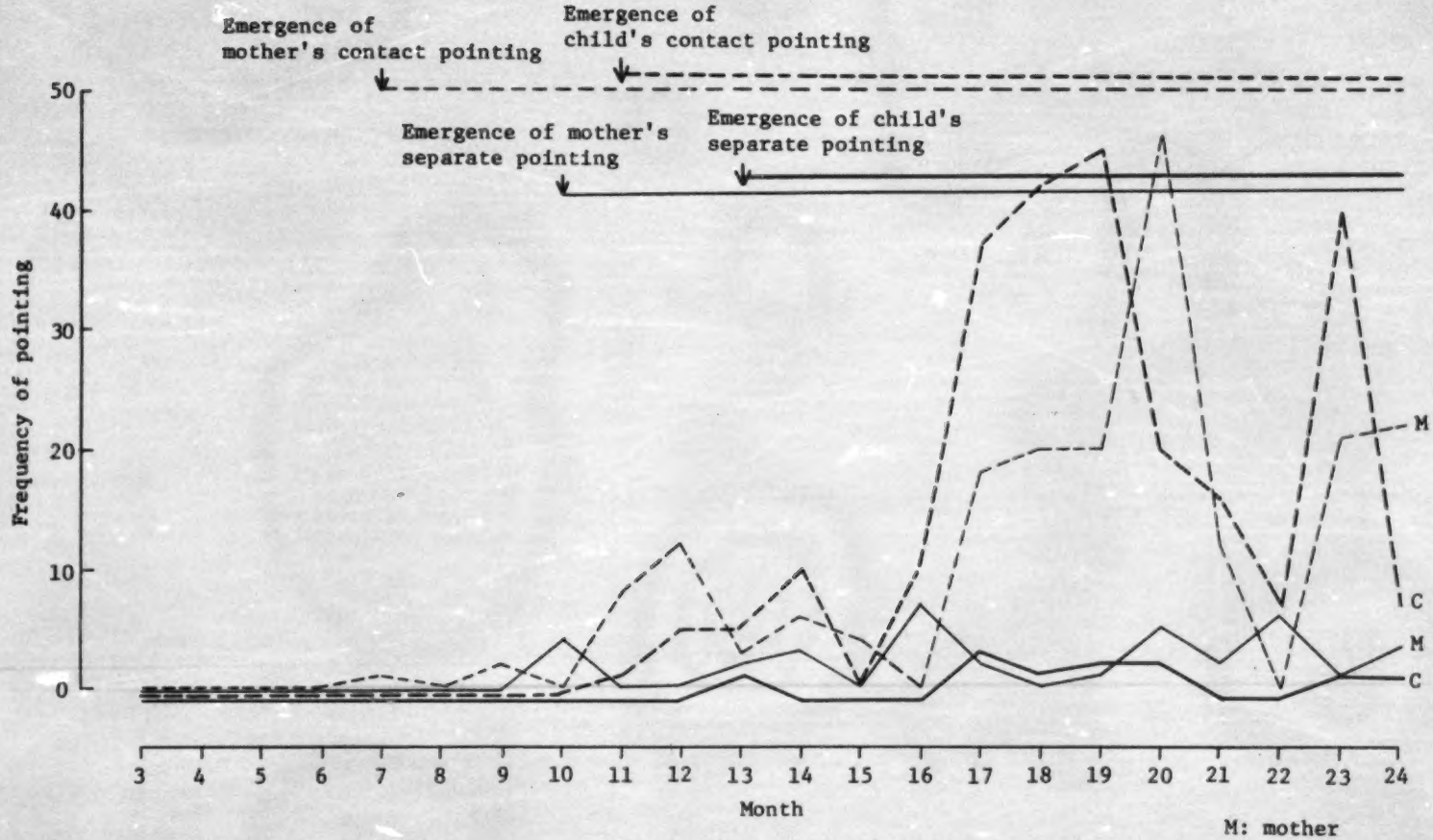

Figure 1 Emergence of pointing in mother and child (A)

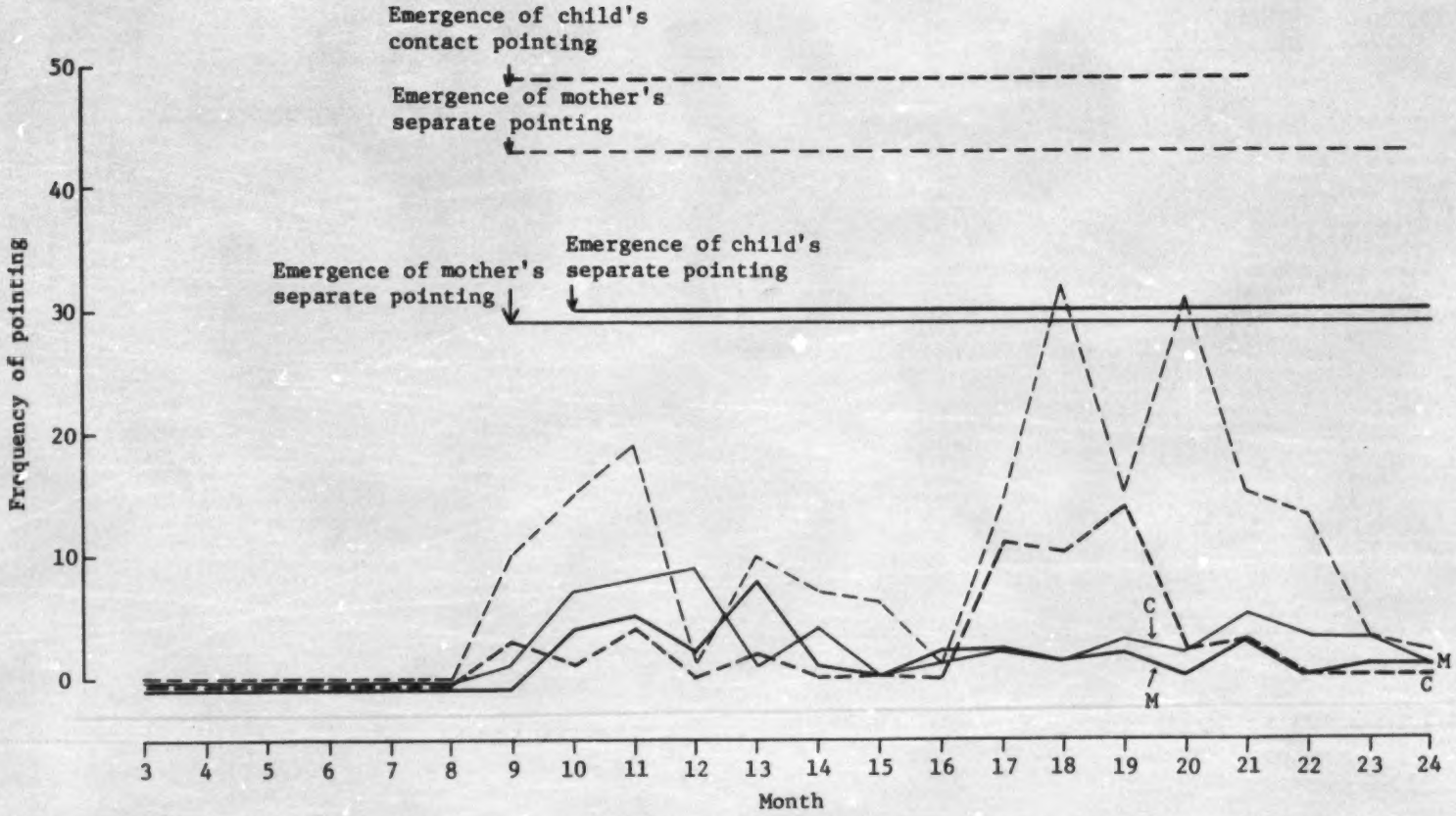

Figure 2 Emergence of pointing in mother and child (B)

M: mother
C: child

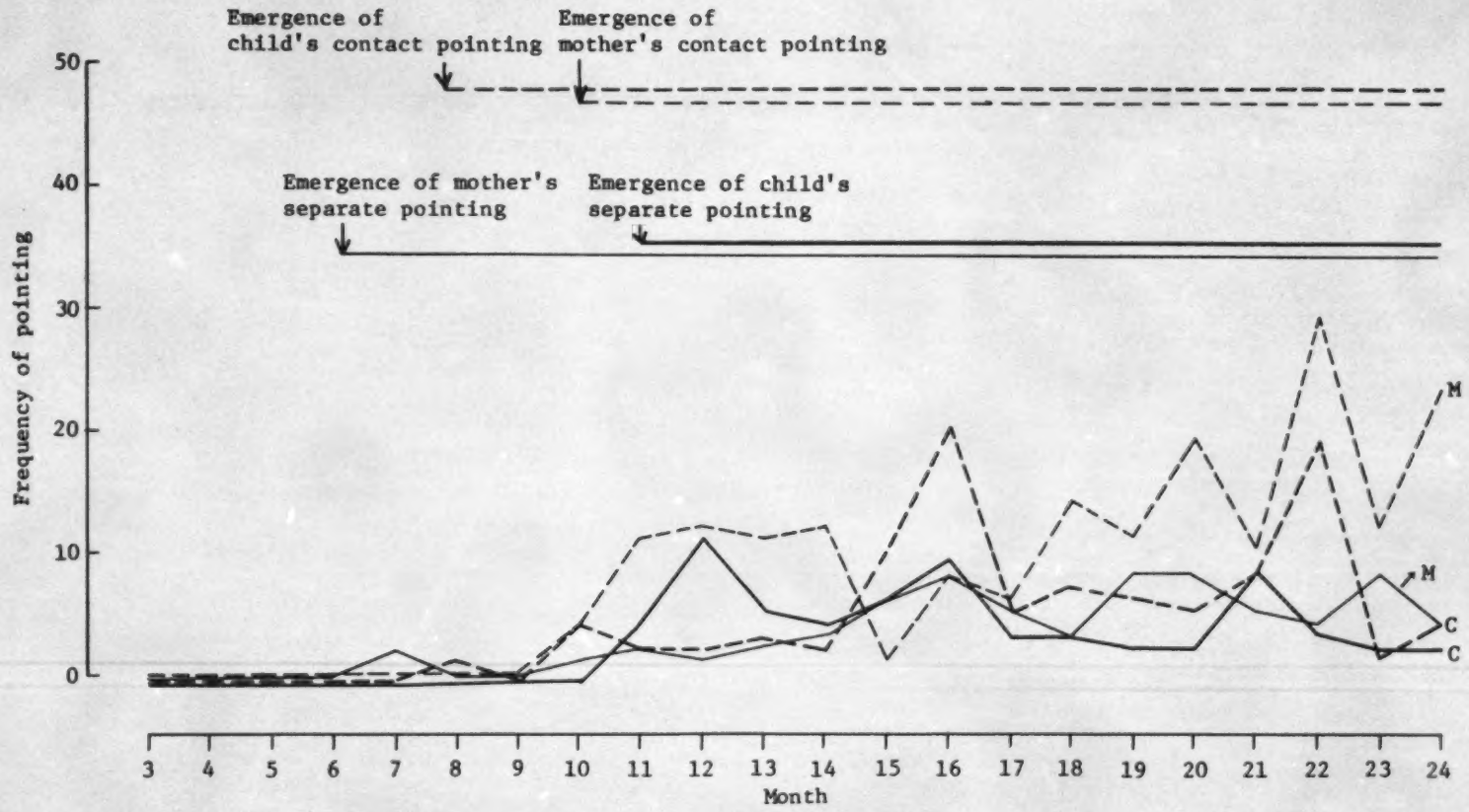

Figure 3 Emergence of pointing in mother and child (C)

M: mother
C: child

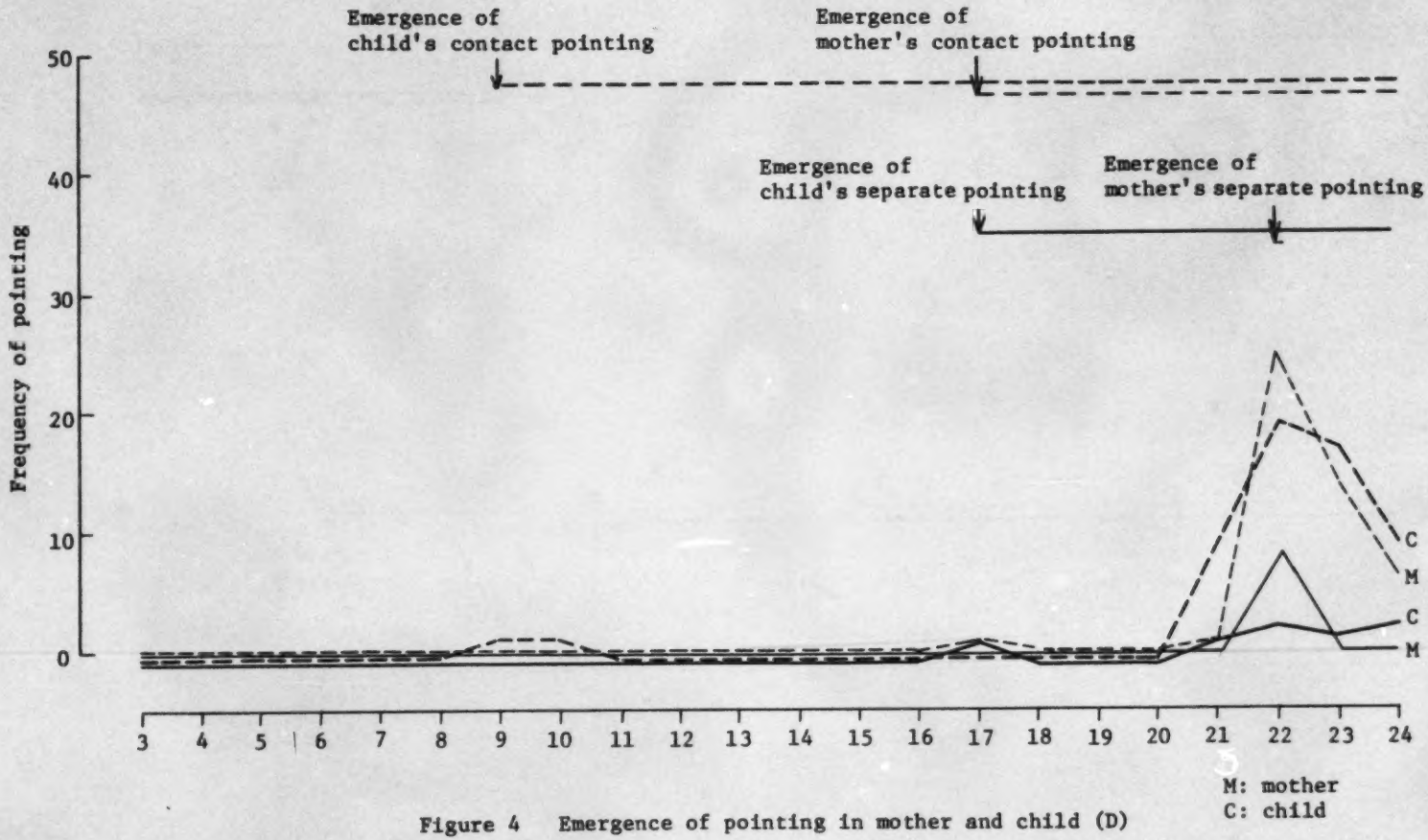

Figure 4 Emergence of pointing in mother and child (D)

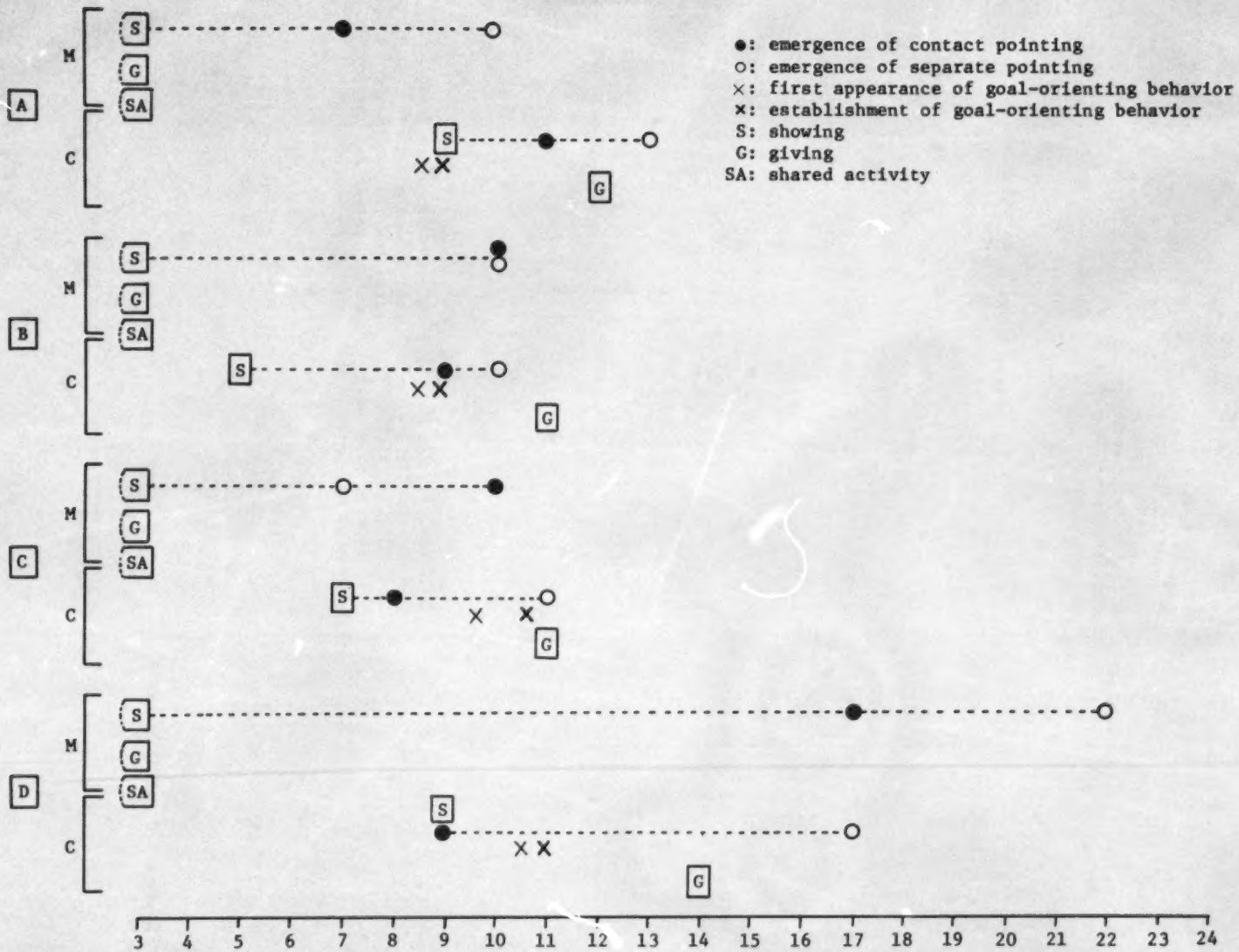

Figure 5 Emergence of searching behavior interposed visual representation, showing, giving and pointing

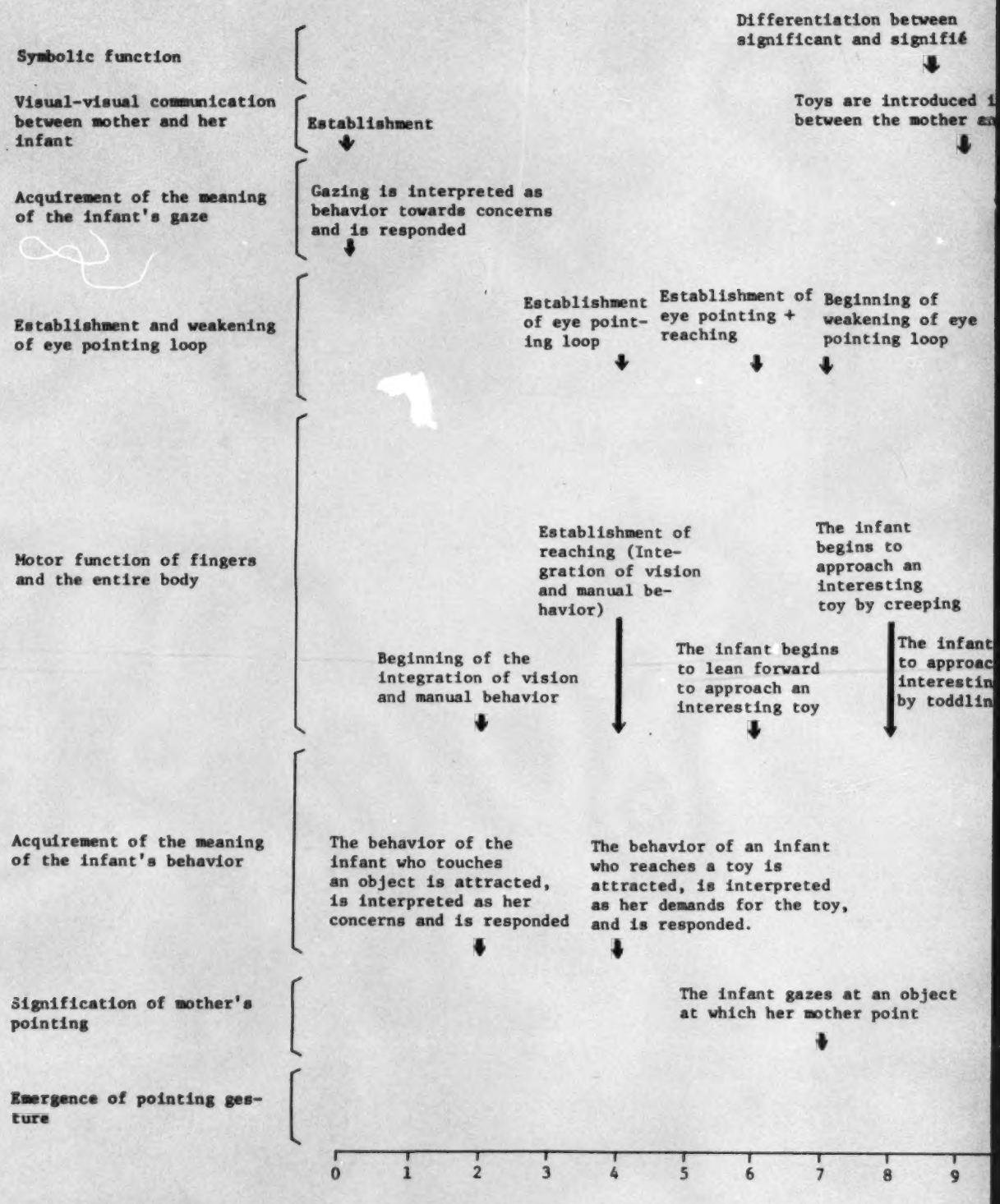
Symbolic function
Differentiation between significant and signifié
Visual-visual communication between mother and her infant
Establishment
Toys are introduced i between the mother an
Acquirement of the meaning of the infant's gaze
Gazing is interpreted as behavior towards concerns and is responded
Establishment and weakening of eye pointing loop
Establishment of eye pointing loop
Establishment of eye pointing + reaching
Beginning of weakening of eye pointing loop
Motor function of fingers and the entire body
Establishment of reaching (Integration of vision and manual behavior)
The infant begins to approach an interesting toy by creeping
Beginning of the integration of vision and manual behavior
The infant begins to lean forward to approach an interesting toy
The infant to approac interestin by toddlin
Acquirement of the meaning of the infant's behavior
The behavior of the infant who touches an object is attracted, is interpreted as her concerns and is responded
The behavior of an infant who reaches a toy is attracted, is interpreted as her demands for the toy, and is responded.
Signification of mother's pointing
The infant gazes at an object at which her mother point
Emergence of pointing gesture
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Figure 6 Conditions for th

the interaction
her infant (showing)

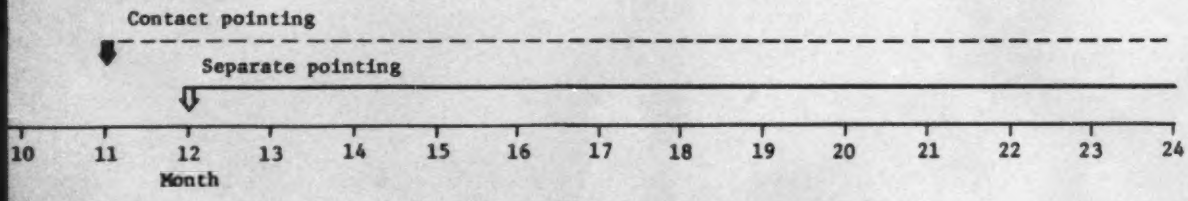
Establishment of poking

The infant begins to approach an interesting object by walking along something

begins an toy

When an infant places or handles a toy in a visual field of her mother, the infant's behavior is attracted and responded by her mother

The infant gazes at an object at which her mother point



emergence of pointing gesture (A)

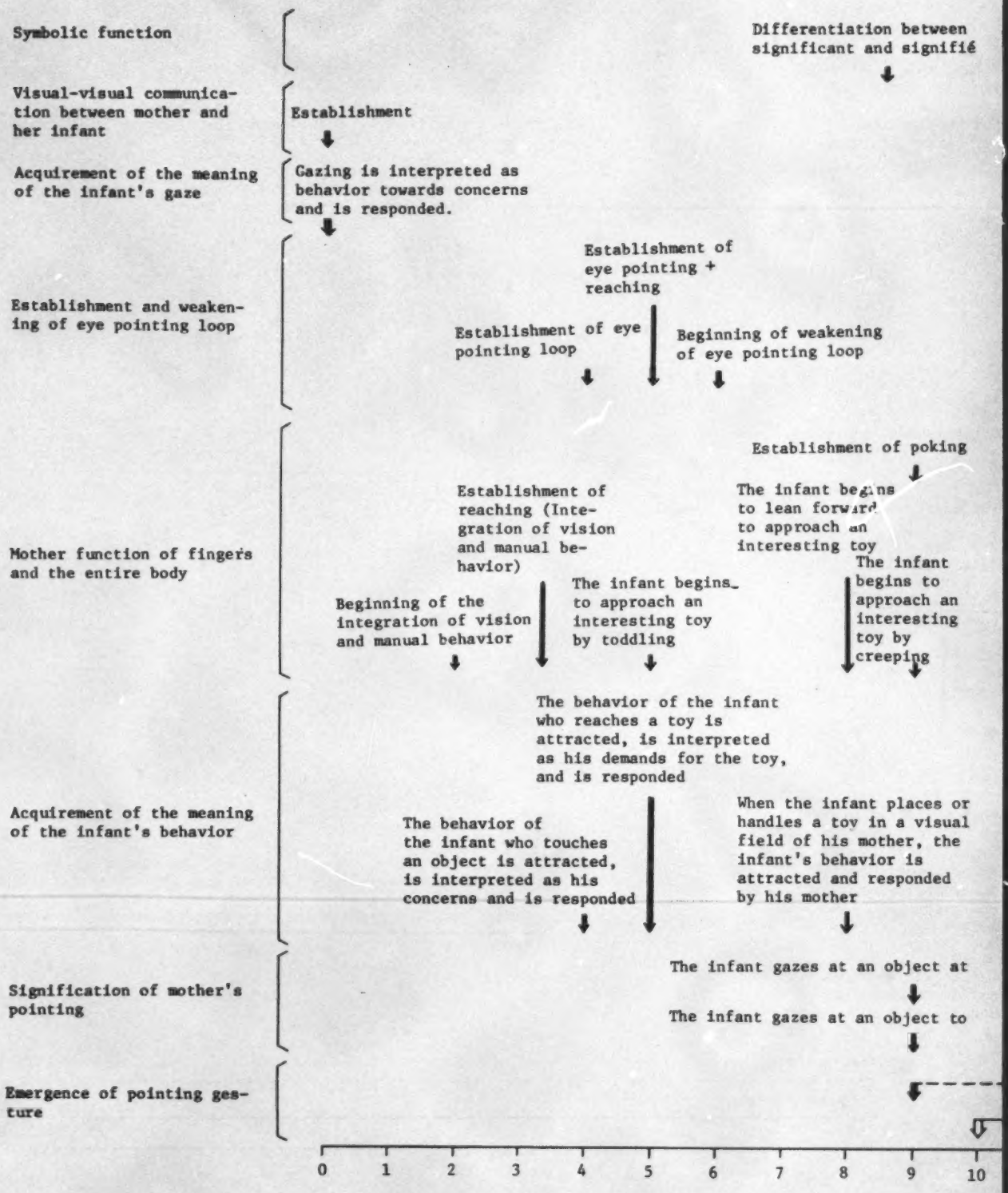

Symbolic function
Differentiation between significant and signifié
Visual-visual communication between mother and her infant
Establishment
Acquirement of the meaning of the infant's gaze
Gazing is interpreted as behavior towards concerns and is responded.
Establishment and weakening of eye pointing loop
Establishment of eye pointing + reaching
Establishment of eye pointing loop
Beginning of weakening of eye pointing loop
Mother function of fingers and the entire body
Establishment of poking
Establishment of reaching (Integration of vision and manual behavior)
The infant begins to lean forward to approach an interesting toy
Beginning of the integration of vision and manual behavior
The infant begins to approach an interesting toy by toddling
The infant begins to approach an interesting toy by creeping
Acquirement of the meaning of the infant's behavior
The behavior of the infant who reaches a toy is attracted, is interpreted as his demands for the toy, and is responded
The behavior of the infant who touches an object is attracted, is interpreted as his concerns and is responded
When the infant places or handles a toy in a visual field of his mother, the infant's behavior is attracted and responded by his mother
Signification of mother's pointing
The infant gazes at an object at
The infant gazes at an object to
Emergence of pointing gesture
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Figure 7 Conditions for the

Toys are introduced in the interaction between mother and her infant (showing)

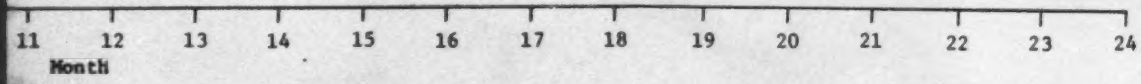
The infant begins to approach an interesting object by walking along something

which his mother points

which his mother points

Contact pointing

Separate pointing



emergence of pointing gesture (B)